Adaptive Task Allocation in Automated Vehicles

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Introduction

Background

- Adaptive Task Allocation (ATA) been shown to improve the monitoring of automated systems (Parasuraman et al., 1996).
- Research on automated systems has shown that the Level of Automation (LOA) can impact situation awareness of operators when performing primary tasks but has little impact on the completion of secondary tasks (Kaber et al., 2004).
- Workload-triggered ATA is a successful method for balancing workload in human-automated machine systems.

Hypotheses

1. Participants will allocate more primary driving tasks to the vehicle and when they encounter driving environments that are higher in perceived workload.
2. Participants will want to conduct manual task allocation during time periods where the perceived workload is low compared to when workload is high.

Methods

Participants

- 156 participants (102 males and 54 females)

Experiment Design: Survey

- 2x2 mixed factorial design: 2 level LOA between subjects, 2 level workload within subjects
- 10 “low” workload driving scenarios and 10 “high” workload driving scenarios (photos and videos) presented
- NASA TLX completed after each driving scenario
- Participant asked to assign 12 tasks to themselves, the vehicle, neither, or neutral (no preference)
- After each video participants asked if they would complete a task allocation in that scenario and if they would prefer manual or automatic allocation.

Results

Mixed Factorial ANOVA yielded the following significant results

Perceived Workload

- Overall, our workload assumptions for the photos were correct, as perceived workload was higher when the workload condition was “high”), than when workload was “low” (*M*=11.53, *SD* = 4.16 vs. *M*=11.15, *SD* =4.42), F(1, 154) = 7.92, p = .008, η_p^2= .05.

Allocation Timing and Preference

- The average percent of the time participants preferred to conduct the task allocation manually was significantly greater when workload was “high” than when workload was “low” (*M*=.74, *SD* = .28 vs. *M*=.67, *SD* =.30), F(1, 154) = 11.00, p = .001, η_p^2= .07.
- There was no significant findings for when participants chose to conduct task allocation.

Preference of “Assign to System”

- The following tasks were allocated to the vehicle significantly more when workload was low

Photos	Videos
Lane changing	Lane changing
Operating turn signals	Operating turn signals
Operating windshield wipers	Activating headlights/high beams
Activating headlights/high beams	
Activating/adjusting cruise control	

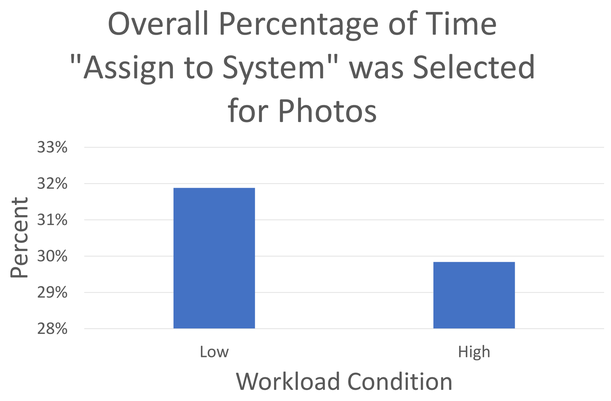

Figure 1.

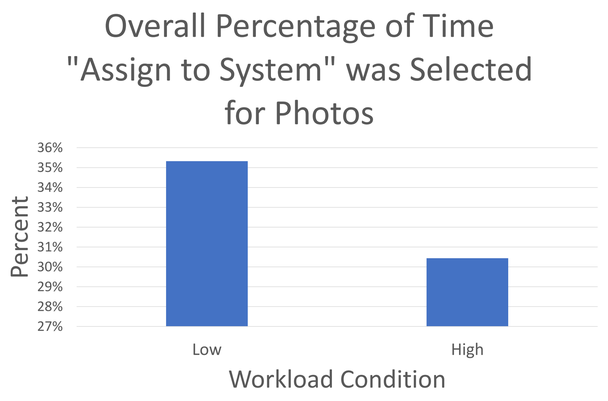

Figure 2.

Conclusion

Discussion

The purpose of this research was to determine what tasks drivers feel most comfortable allocating to an automated vehicle under certain driving environments. Results of this research disproved the hypotheses and found that secondary tasks are more frequently allocated to the vehicle system when workload is high, and drivers prefer manual task allocation when workload is high. The results also found that drivers prefer to assign more tasks to the vehicle when workload in lower. This study should be replicated in a driving simulator for more significant results with respect to LOA.

References

Kaber, D. B., & Endsley, M. R. (2007). The effects of level of automation and adaptive automation on human performance, situation awareness and workload in a dynamic control task. Theoretical Issues in Ergonomics Science, 5(2), 113–153. https://doi.org/10.1080/1463922021000054335

Parasuraman, R., Mouloua, M., & Molloy, R. (1996). Effects of Adaptive Task Allocation on Monitoring of Automated Systems. Human Factors, 38(4), 665–679. https://doi.org/10.1518/001872096778827279

SAE International. (2021, April 30). J3016C: Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles - SAE International. https://www.sae.org/standards/content/j3016_202104/.

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